

# ACCELERATED CONCEPT EXPLORATION OF FUTURE COMBAT SYSTEMS USING EVOLUTIONARY ALGORITHMS AND ENTERPRISE SOFTWARE

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## SUMMARY

Army R&D labs have played a crucial role in the evaluation of emerging systems that equipped the war fighter with superior lethality. The Future Combat System's (FCS) aggressive acquisition strategy of conventional (armor, munitions, propulsion) and non-conventional (unmanned sensors, robotics) technologies place a greater demand on labs for rapid and accurate analysis of potential weapon systems. A combination of validated engineering analysis codes, Evolutionary Algorithms (EA) and Enterprise Commercial Off the Shelf Software (COTS) can greatly accelerate the evaluation of candidate systems.

## 1. INTRODUCTION

Traditional Modeling and Simulation (M&S) activities are not well suited for today's acquisition environment. In particular, they suffer from: premature design commitment, a failure to quickly identify dominant design factors and adapt to changing design requirements. Many of these problems stem from a lack of human engineering concurrency and communication. A partial solution to this problem is to enable virtual collaboration among a lab's modeling and simulation codes. Genetic Algorithms (GA), a subset of EA's, are an ideal catalyst for multi-disciplinary concept exploration. GA's mimic the selection process that occurs

among biological species in nature [1], but to various engineering disciplines they provide an excellent focal point in determining a weapon system's optimal configuration based on a set of given mission parameters. The organizational and cultural impact of setting up this type of virtual cooperation is far reaching and cannot be overstated.

Concept exploration engines have been around for a number of years; an outstanding example is the Integrated Hypersonic Aeromechanics Tool (IHAT) used at Naval Air Command, China Lake to design hypersonic air breathing vehicles in the Mach 4-8 regime [2]. Likewise, the Aviation and Missile Command, Research, Development, and Engineering Center (AMRDEC) has adopted a multi-disciplinary approach through its Army Missile Collaborative Design Environment (AMCODE).

## 2. AUTOMATING DESIGN SPACE SEARCHES

Design space searches with GAs can be CPU expensive. It is important to identify tiers of fidelity for each engineering discipline. AMCODE is transitioning through three phases of complexity. The first phase was based on the work of Burkhalter, Jenkins, and Hartfield [3]. This phase successfully demonstrated design space searches on a single machine using closed form solutions. The next phase effectively demonstrated the same searches

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in a distributed environment on the local network using Python Remote Objects which reduced the search time from 34 hours to 2 hours.

The third phase will involve the integration of mid- and high-fidelity analysis tools currently used by AMRDEC engineers. The only criterion the tools must meet is that they: 1) provide an Application Programming Interface (API) or 2) be command line invoked and initialize with text input files, or 3) have access to the tool's source code. Each tool's input and output information will be mapped to a Relational Data Base Management System. (RDBMS) via high level scripting languages

### 3. ENTERPRISE SOFTWARE

Enterprise software defines a group of applications that are utilized at the organizational level. Popular examples include: Sun ONE Integration product line, IBM's WebSphere products, and Microsoft's Windows Server System. These products all have one thing in common – they provide significant out-of-the-box functionality for managing large amounts of data and they are easily extensible by trained software developers. Traditionally, enterprise software has been the domain of Information Technology (IT) professionals – yet Army scientists and engineers in R&D labs can benefit enormously from these information handling technologies in conducting design space searches. Software pricing is attractive for Army R&D labs and can be found at the Army Small Computer Program website. Windows Enterprise Server and SQL Enterprise Server are \$3260.00 and \$26,709 respectively per license as of FY04 [4].

Once the tool's input and output information has been mapped to the

RDBMS, the engineer has wide flexibility in directing the design space search. A possible configuration that utilizes Web Services is shown in figure 1.

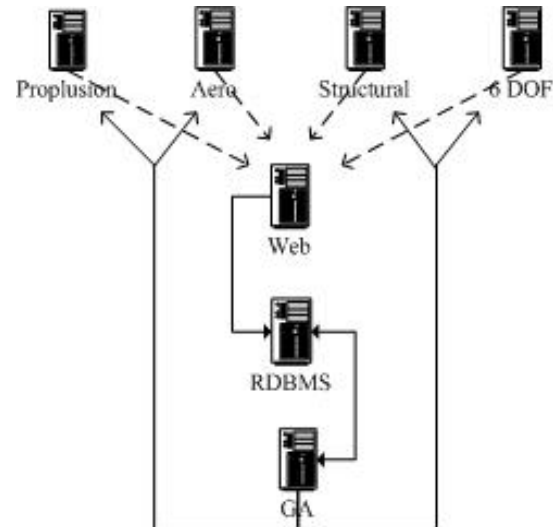


Figure 1. Web Services Configuration

Note that the data flow is one way through the computers running the engineering codes – this configuration's processing throughput is limited only by the number of available processors.

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- [3] J. Burkhalter, et al, *Missile Design Synthesis Genetic Algorithm Method*, Final Report December 2002
- [4] Army Small Computer Program, <https://ascp.monmouth.army.mil/scp/>